TOPICAL REPORT
CSTC TOPIC 2004-E
CHEMICAL EXPOSURES DURING CLOSURE ACTIVITIES

Acknowledgements:

It is necessary and appropriate to express my thanks for the following people or organizations that made completion of this report possible:

- Marco S. Colalancia, CIH, whose vision inspired its creation, who wrote the introduction to the report, and who led the project almost to completion until compelled to relinquish the assignment for reasons beyond his control.

- Billy Lee, the DOE HQ Sponsor, whose enthusiasm for the project kept it going when it might otherwise have faltered.

- The DOE Offices at Savannah River and Rocky Flats who encouraged and promoted the project.

- Margaret Marks, Director of the Miamisburg Closure Project, and Tom Williams, Director of the Ashtabula Closure Project (now of EH), for requiring their site contractors to support the project.

- At the Fernald Closure Project - Don Fleming, CIH (now at NIOSH); Roger Grant, CIH; Todd Valli, CIH; and Walt Mengel, CIH; who each provided industrial hygiene monitoring data, assisted in interpreting it, and reviewed the draft case studies describing the sampling at their project.

- At the Ashtabula Closure Project - Mike McElhinny, CIH, who provided industrial hygiene monitoring data, assisted in interpreting it, and reviewed the draft case studies describing the sampling at his project.

- Dan Marsick, CIH, and David Weitzman, CIH, of DOE HQ, for their peer review of the final report.

- Harvey Grasso, CIH, of the Livermore Site Office, and Sally Starling of the Savannah River Office, for providing material in support of the project, that unfortunately did not fit into the report's format.

Geoffrey Gorsuch, CIH
Miamisburg Closure Project
Ohio Field Office

Abbreviations:

ACGIH – American Conference of Governmental Industrial Hygienists
AEC – Atomic Energy Commission
AL - Action Level
ANSI - American National Standards Institute
HEPA – High Efficiency Particulate Air
LLW – Low Level Waste
Mg/m3 – Milligram Per Cubic Meter
ND – Not Detected
NIOSH – National Institute for Occupational Safety and Health
NO2 – Nitrogen Dioxide
OSHA – Occupational Safety and Health Administration
OSDF – On-Site Disposal Facility
PAPR – Powered Air Purifying Respirator
PEL - Permissible Exposure Limit
PF – Protection Factor
PNOS – Poorly Soluble, Not Otherwise Specified
PPM – Parts Per Million
RCRA – Resource Conservation and Recovery Act
REL – Recommended Exposure Limit
RMI – Reactive Metals Incorporated
SCBA – Self-Contained Breathing Apparatus
SO2 – Sulfur Dioxide
STEL – Short Term Exposure Limit
TLV - Threshold Limit Value
TWA – Time Weighted Average
UNH – Uranyl Nitrate Hexahydrate
WAC – Waste Acceptance Criteria

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1. INTRODUCTION

The U.S. Department of Energy (DOE) has stewardship responsibilities for hundreds of sites and facilities across the country and throughout the world. As these sites and facilities reach the end of their useful operational lives, DOE's closure activities take on a high level of importance. These closure activities are important to the public, and residents of the surrounding communities have a vested interest in terms of potential risk reduction.

Just as overall risk reduction is important for the public, the control of hazardous exposures during closure activities is important for the workers. This report discusses various chemical exposures associated with closure tasks and reviews several actual case studies from two field offices, Ohio and Rocky Flats

2. CLOSURE ACTIVITIES AND CHEMICAL EXPOSURES

Chemical exposures received by workers during closure activities can be acute or chronic in nature. The toxicology of individual chemicals to which the worker may be exposed, coupled with potential synergistic effects of chemical mixtures that may be encountered in the workplace, presents a stubborn challenge when documenting exposures. Exposures can vary widely depending on the chemical or mixture of chemicals encountered during closure and remediation efforts. Local work-site conditions can also vary significantly. Lastly, potential exposure pathways vary depending on the worker's specific task.

This report focuses on chemical exposures that can result from closure activities and intentionally does not address radioactive materials or radioactive exposures.

3. CURRENTLY APPLICABLE REGULATORY REQUIREMENTS

In DOE Order 440.1A, DOE established the framework for effective worker protection programs, with the objective of reducing or preventing injuries, illness, and accidental losses by providing a safe and healthful workplace. Within this framework, DOE and its contractors are required to follow Occupational Safety and Health Administration (OSHA) regulations. In addition, paragraph 4.L of DOE O 440.1A requires that chemical exposures be limited to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) or OSHA's Permissible Exposure Limits (PELs), whichever is more protective. By specifying the more protective of the limits, DOE emphasizes the importance of minimizing chemical exposures.

4. THE CHALLENGES OF CLOSURE ACTIVITIES

Closure activities, by their nature, present special challenges with respect to hazardous exposures. Because of the non-repetitive nature of the work, errors caused by improper planning or improper work execution can be greatly amplified. In such a dynamic work environment, exposure conditions can vary widely from day to day. Conditional variations in the work environment make the goal of exposure minimization very difficult to achieve. By way of contrast, chemical exposures and exposure routes associated with manufacturing or other routine work environments can often be well characterized and, therefore, more readily controlled and minimized.

Because closure activities are generally "projectized" efforts, information is often not exchanged and lessons learned are not widely shared among projects. As a result, opportunities increase for repeated exposures caused by essentially the same circumstance. Once exposure mechanisms are identified, they can be studied and eventually understood, leading to better control and an overall risk reduction for individuals who are tasked with performing closure activities.

In an effort to exert greater control over potential chemical exposures during closure activities, a set of case studies has been compiled to encompass the entire closure life cycle of DOE facilities. These case studies have been analyzed, and general conclusions have been drawn about potential exposure mechanisms and guidance for enhancing worker protection.

The case studies compiled in this report have been binned into the following five major chronological stages of the closure life cycle:

- Containerized Chemical Removal
- Decontamination
- Decommissioning
- Demolition
- Soil Remediation

Although conceptually these stages may be planned to occur in serial order, it is not uncommon for one or more of these stages to overlap as work is conducted to meet closure schedules. This overlap may lead to far greater challenges in chemical exposure assessment, considering the distinctly different nature of exposure pathways in the various stages and work tasks.

In addition to the above-mentioned challenges, DOE contract reform initiatives have introduced another variable into the mix: the presence of new subcontractors with little DOE experience in performing closure activities. Often, these subcontractors possess only limited knowledge of prior facility missions, and therefore they may be inadequately prepared to perform their subcontracted work tasks. For example, commercial demolition contractors working in general industry are familiar with dust suppression techniques at a demolition site to ensure that environmental criteria are met; however, they may not be aware that chemical contamination could be managed in the same way. A lack of hazard awareness could lead to improperly maintained radiological boundaries, which in turn could lead to workers tracking contamination outside their work zones, leading to potential contaminant migration from work zones to unaffected areas, to surrounding areas, and even to off site.

In closure activities, prototypical work tasks present additional hazards in execution. Due to their nature, unanticipated exposures can occur because of the higher likelihood that unknown or previously un-experienced situations can arise. By building an experience base, prototypical work task outcomes can be shared across multiple sites, thereby preventing the same prototypical “blindsides” that could again occur at another work site. Lastly, challenges also arise as a result of poorly executed hazard characterization and planning efforts that precede work. Subcontracts describe general hazards associated with closure activities, but more detail is usually necessary beyond the contract level. Details are needed at the individual task level to identify and describe the specific hazards identified for each task.

The challenges faced by DOE and its closure activity contractors can be minimized by:

- enhancing work orchestration between multiple contractors on a closure activity site,
- ensuring an acceptable level of training for subcontractor personnel, and
- providing continued oversight of subcontractors by prime contractors and/or DOE.

5. CONCLUSIONS

The conclusions drawn from these case studies illustrate two common themes:

- Improved work practices are often successful in minimizing exposures and
- Substandard work practices must be avoided.

SUCCESSFUL EXPOSURE MINIMIZATION PRACTICES

Based on information obtained from the case studies, exposure-minimizing practices are:

- Ensure that proper time and effort have been expended on work hazard identification and planning to minimize the opportunity for finding undefined hazards.
- Practice decontamination prior to decommissioning or cutting by means of a saws-all or torch.
- Use engineering controls such as ventilation and containment tents to reduce the likelihood of exposure to co-located workers.
- Be conservative in the choice of personal protective equipment (PPE) until characterization allows reduction in the level of PPE required.
- Administratively control the time that workers can perform work.

PRACTICES TO AVOID

- Hasty work planning.
- Manually handling contaminated parts without first decontaminating them.
- Reducing PPE requirements before obtaining verifiable sampling results.
- Ignoring engineering control inadequacies and favoring the use of PPE.
- Working on a closure activity without the benefit of characterization data.

In conclusion, the case study information provided by the Ohio and Rocky Flats Sites reinforces accepted methods for safely performing closure activities. Time-tested successful exposure minimization practices do work. Having a comprehensive understanding of what constitutes a hazard related to work activities at the floor level, coupled with good planning, training, and execution, will lead to successful work performance.

Contractors performing closure activities are often limited in how much support they can give to information-gathering activities such as this report. However, such information is valuable for increasing the body of understanding regarding closure activity hazards. Therefore, additional case study information should continue to be gathered in the future to provide an experience-based resource to DOE, as a means to further enhance workplace safety and to build on the practical and useful body of exposure minimization understanding.

CASE STUDIES: CONTAINERIZED CHEMICAL REMOVAL

Case Study: Packaging of Lead-Acid Batteries and Lead Shapes at the Fernald Closure Project

Introduction

Lead-acid batteries are normally commercially recycled, but damaged or potentially radiologically contaminated batteries are typically drummed and placed in RCRA storage. Lead shapes included items such as lead bricks, sheeting, and hammers and building materials such as window casings and roof flashing and were typically stored in drums or metal boxes. Waste batteries and lead shapes typically require handling when they are repackaged into the proper shipping containers for transport and disposal.

Synopsis of Event

The batteries and shapes were handled inside a 40- by 40-ft containment with compartments for processing, staging/buffering, and donning/doffing of protective clothing. The containment was provided with general fresh air ventilation and exhausted through HEPA filtration. Local exhaust was also used in certain handling areas. The supply air flowed from the cleaner to the more contaminated areas. Personal protective equipment worn during handling activities included full-facepiece air-purifying respirators with Super/HEPA combination cartridges having an assigned protection factor (PF) of 50.

Within the containment, batteries and shapes were removed from storage containers, inspected, and packed into shipping containers. If already in a container suitable for shipping, the contents were inspected, and if no liquid was present, absorbent was added and packed for shipment.

Air monitoring during the processing of batteries and shapes was performed between April and August 2002, and the results are summarized in Tables 1-4. The OSHA PEL for lead referenced is 50 $\mu g/m^3$, and the Action Level (AL) is 30 $\mu g/m^3$. It should also be noted that “Above the PEL” in the tables refers to the concentration in air, not the employee exposure level when the PF of the respiratory protection was taken into account.

Table 1. Sampling for Inorganic Lead

Activity	Number of samples and dates collected	Lead concentration ($\mu g/m^3$)	Lead 8-hr TWA ($\mu g/m^3$)
Repackaging lead-acid batteries	36 breathing zone samples collected between April 24 and June 3, 2002	18 above OSHA PEL Range of 59.5 to 179 Average of the 18 was 99.6 Three others were above the OSHA AL	12 above OSHA PEL Range of 54.3 to 124 Average of the 12 was 83.52 Three others were above the OSHA AL; of the others, the average was 6.9, and two were non-detectable

Notes: Activities monitored included battery handling, cleaning the workroom and electrolyte collection tray, cleaning batteries for recycle, preparing containers for crushing, brushing lead-acid battery drums. Ten of 12 exposures above the 8-hr TWA occurred during battery handling and one during battery cleaning for recycle.

Table 2. Sampling for Inorganic Lead

Activity	Number of samples and dates collected	Lead concentration ($\mu g/m^3$)	Lead 8-hr TWA ($\mu g/m^3$)
Repackaging lead shapes	16 breathing zone samples collected between June 12 and 24, 2002	Six above OSHA PEL Range of 62.5 to 179 Average of these 6 was 89.2 None were above the OSHA AL	Two above OSHA PEL Range of 51.3 to 147 None were above the OSHA AL (average of other samples was 4.19, and one was non-detectable)

Table 3. Sampling for Inorganic Lead – Area Monitoring

Number of samples and dates collected	Lead concentration ($\mu g/m^3$)
29 area samples collected between April 24 and June 20, 2002	Range of detectable samples, 0.4 to 23.1 Average was 3.63, and seven were non-detectable

Table 4. Sulfur Dioxide

Activity	Number of samples and dates collected	Sulfur dioxide 15-min STEL (ppm)	Sulfur dioxide 8-hr TWA (ppm)
Handling batteries	9 breathing zone samples collected between April 23 and May 2, 2002	Range, 0.2 to 1.0 Average - 0.45	Range, 0.04 to 0.44 Average - 0.11

Note: The DOE Occupational Exposure Limit for this gas would be a STEL of 5 ppm and an 8-hour TWA of 2 ppm.

Conclusions and Recommendations

Although lead exposure levels were higher than anticipated, no employees were overexposed if the PF of the respiratory protection is taken into account. It is believed that exposure was at least in part the result of unavoidable handling of the batteries and shapes away from the local exhaust ventilation. Often, the handling was close to the body because of the weight of the object.

Wiping down the batteries and shapes or using fixatives might reduce future lead exposure. More careful placement of local exhaust and frequent HEPA vacuuming might also reduce lead exposure. Late receipt of sampling results coupled with rapid completion of the work activity made the performance of additional air monitoring under modified controls impossible.

The implementation of more elaborate engineering controls for an operation of such short duration was not feasible.

Case Study: Hand Sorting and Preparation of Drummed Mixed Waste

Introduction

In 1962, the RMI facility in Ashtabula began the extrusion of depleted, natural, and slightly enriched uranium rods, tubes, and shapes for the Atomic Energy Commission (AEC). The metal to be extruded was received from AEC feed production sites at Fernald and Weldon Springs in the form of ingots and billets. Extrusion was done using a 3850-ton press. Some extruded products would eventually become fuel elements in DOE plutonium production at Hanford and Savannah River.

To make the uranium ingots and billets malleable for extrusion, they were treated in a molten salt bath at about 1300ºF. The main component of this salt bath was barium chloride. The extrusions were run out on a bed of graphite, and graphite was also used as filler material to clear extruded metal. All production at the site ceased in 1989. During its years of operation, the extrusion facility became contaminated with uranium, both loose and fixed, mixed with graphite and barium chloride.

During site remediation, this waste was collected and drummed. Together, the uranium and barium chloride contamination constituted mixed waste, totaling about 90 drums. It was determined that this mixed waste should be treated on site by micro- or macro-encapsulation (within an impermeable plastic sheath) and then shipped to Utah for disposal. However, Utah's Waste Acceptance Criteria (WAC) would not allow high levels of graphite contamination, so the graphite had to be separated from the mixed waste and disposed of separately. Other restricted items not allowable under the Utah WAC also had to be removed from the drums.

Synopsis of Event

The drums were opened and the mixed waste was hand sorted and repackaged in a booth built for that purpose. The booth was operated under negative pressure and was exhausted through HEPA filtration. Personal air monitoring results for barium during this activity are shown in Table 1.

Table 1. Personal Monitoring for Barium

Date	Activity	Airborne level (mg/m^3)	8-hr TWA (mg/m^3)
10/30/00	Sorting drums	0.0837	0.0023
10/31/00	Sorting drums	0.0158	0.009
11/1/00	Sorting drums	0.0129	0.010
11/1/00	Waste preparation	***1.4555***	***0.788***
11/2/00	Waste preparation	0.0048	0.003
11/2/00	Sorting drums	0.1127	0.065
11/3/00	Waste preparation	0.0030	0.002
11/3/00	Sorting drums	0.0309	0.024
11/6/00	Sorting drums	0.0132	0.012
11/6/00	Waste preparation	***1.7511***	***1.218***
11/7/00	Sorting drums	0.0046	0.003
11/7/00	Waste preparation	***0.6207***	***0.517***
11/8/00	Sorting drums	0.0569	0.047
11/8/00	Waste preparation	0.0468	0.037
11/16/00	Sorting graphite	0.0095	0.007
12/1/00	Sorting/segregating graphite	0.0024	0.002
12/4/00	Sorting graphite	0.0079	0.007

Note: Bolded and italicized results exceeded the OSHA PEL and ACGIH TLV of 0.5 mg/m^3 for barium. However, employees performing these activities were wearing full-facepiece powered air-purifying respirators (PAPR) with HEPA filters.

Each air sample was also analyzed for lead, chromium, and cadmium. All cadmium 8-hr TWA airborne concentrations were less than 0.2% of the PEL. Chromium 8-hr TWA airborne concentrations averaged 0.3% of the TLV with the high concentration being 3.2 % of the TLV. Lead 8-hr TWA airborne concentrations averaged 1.8% of the PEL with a high concentration of 5.8% of the PEL. Area samples taken outside the booth showed airborne concentrations for barium at about 0.06% of the TLV and less for other contaminants.

Conclusion and Recommendations

Engineering controls were effective in protecting employees working outside the booth from exposure, and in protecting areas outside the booth from contamination. PAPRs having an assigned protection factor of 1000 (per ANSI Z88.2-1992) prevented employees working inside the booth from overexposure to barium. The same controls were also required to help prevent radiological exposure and contamination.

Sampling results for metals with low PELs and TLVs provided additional documentation of safety during the sorting and preparation of drummed mixed waste.

Case Study: InstaCote™ Oversized Low-Level Waste (LLW) to Transport from Rocky Flats Environmental Technology Site to Disposal Facilities

Introduction

Large pieces of low-level waste (LLW) are wrapped and InstaCote™ is applied to eliminate the need for size reduction of equipment and machinery at Rocky Flats during D&D operations. Size reduction creates many safety hazards that can be eliminated through this packaging technique.

Synopsis of Event

On April 23, 2002, workers staged furnaces on a shipping platform (Fig. 1), wrapped the furnaces with Dr. Shrink™ (Fig. 2), and applied InstaCote™ (Fig. 3). InstaCote™ is a sprayable poyurea elastomer that creates a tough, durable coating, which serves as a tight container meeting DOT regulations for shipment of LLW.

One component of InstaCote™ is methylene bisphenyl isocyanate (MDI). Occupational exposure to MDI can produce significant respiratory effects. Symptoms can include asthmatic breathing, retrosternal soreness, constriction of the chest, cough, retrobulbar pain, depression, headache, and insomnia. Because of the MDI, personal breathing zone samples were taken on employees who apply the coating. Sampling was conducted using a 37-mm cassette and sampling pump. The following chart compares the sampling results with the OSHA PEL and the ACGIH TLV.

Job task	Time-weighted average (TWA)	8-hr TWA	OSHA PEL	ACGIH TLV (8-hr TWA)
Sprayer	0.1858 mg/m³	0.0232 mg/m³	0.20 mg/m³	0.005 mg/m³
Worker assisting the sprayer within 5 ft	0.2063 mg/m³	0.0155 mg/m³	0.20 mg/m³	0.005 mg/m³
Worker assisting the sprayer > 5 ft	0.1431 mg/m³	0.0080 mg/m³	0.20 mg/m³	0.005 mg/m³

Conclusions and Recommendations

Through the use of InstaCote™ as a packaging technique for LLW, the potential for injuring workers has been reduced, and time and money have been saved.

InstaCote™ contains methylene bisphenyl isocyanate (MDI), which poses a hazard if not controlled and monitored. Workers in this activity should wear appropriate personal protective equipment (PPE), including supplied-air respirators, as needed based on the potential exposure of the employee. Industrial hygiene sampling should also be completed to determine job task exposure for each employee.

Improvements could be made in sampling techniques. There is a potential to underestimate levels when sampling using a Teflon and impregnated 37-mm filter due to not collecting all aerosols. MDI has low but significant vapor pressure; therefore, there is a potential for both vapor and aerosol exposure. For this reason, when using an indirect sampling method, an impinger with a 13-mm filter should be used to collect both vapors and aerosols.

Use of InstaCote™ as a packaging technique has many benefits for a closure site; however, its use must be well controlled to protect the worker from MDI, which is a constituent of InstaCote™. The controls for this work were in the form of PPE, ventilation controls in the immediate area, and controlling the conduct of the work using work planning documents.

Fig. 1 - Furnaces prior to being covered with Dr. Shrink™ shrink wrap

Fig. 2 - Furnaces after being covered with Dr. Shrink™ shrink wrap

Fig. 3 - InstaCote™ being applied to furnaces

CASE STUDIES: DECOMMISSIONING

Case Study: Characterization of Equipment at Former Beryllium Research and Development (R&D) Facility

Introduction

Since its establishment in 1948, several buildings at the Mound Laboratory were known to have housed operations that involved beryllium-containing materials. Among these were DS, T, and SW Buildings, in which beryllium metal vaporization equipment, machine shop and neutron-generating equipment, and a lathe, respectively, were contained. Mound's R Building contained at least 14 rooms that were at one time used for beryllium R&D, with three more rooms containing laboratories in which beryllium was used by chemists. Air sampling performed during some of the historical activities in these buildings demonstrated the likelihood of significant employee exposure. By the time site closure activities began, however, work with beryllium had been stopped for over a decade.

Found in one of the rooms historically associated with R&D were sheets of beryllium metal, a container of beryllium, and an electron beam welder. Wipe sampling on R building floors and counter surfaces had shown no detectable contamination. Although the operator of the tool claimed that it had never been used with beryllium, the welder was considered potentially contaminated, so characterization of internal surfaces was warranted. Because of the potential for exposure, the industrial hygienist who entered the room to perform wipe sampling wore a full-facepiece air-purifying respirator with HEPA cartridges, and a complete set of anti-contamination clothing. The room containing the equipment was treated as a controlled area.

Synopsis of Event

The results of breathing zone monitoring are shown in Table 1.

Table 1. Breathing Zone Air Sampling Results

Date of sampling	Total beryllium (µg)	Time-weighted average (TWA) for period sampled (µg/m^3)	10-hr TWA exposure (µg/m^3)
March 2001	< 0.1	< 0.0004	< 0.000069

Notes:

(1) The sampling pump ran 104 minutes.

(2) The OSHA and DOE Permissible Exposure Limits for 8-hr TWAs are both 0.002 µg/m^3. However, because the site works four 10-hr days weekly, the TWA is reduced to 0.0016 µg/m^3.

Despite the lack of detectable beryllium in the air sampling, wipe sampling showed some internal contamination. Of nine wipe samples, two showed levels of 21 and 22 µg/100 cm^2. Four others averaged 2.35 µg/100 cm^2 (ranging from 2.0 to 2.7 µg/100 cm^2). No beryllium was detected on three samples (level of detectability of 0.1 µg). The DOE surface contamination criterion for release to the general public is 0.2 µg/100 cm^2, and the criterion for intra-DOE release is 3.0 µg/100 cm^2.

Conclusion and Recommendation

Given the potential hazard from beryllium inhalation, the precautions taken to prevent unnecessary overexposure were probably justified. General building history and the presence of beryllium-containing materials in the room indicated the potential for internal contamination of the welder. General wipe sampling of building surfaces and the operator's memory indicated no internal contamination.

Wipe sampling results, however, showed internal contamination above releasable levels and indicated that the electron beam welder likely had been used on a beryllium-containing material after all. Because of the level of contamination found and the likely high cost of successful cleaning, continued attempts at decontamination of the welder to allow its release were not recommended.

CASE STUDIES: DEMOLITION

Case Study: Size Reduction of 1950s-Era Uranium Metals Processing Building

Introduction

The RMI Main Plant Building was constructed in the mid-1950s to house a titanium/zirconium sponge compaction facility, but it was never used for that purpose. Instead, in 1961 it was modified to hold an AEC-owned 3850-ton extrusion press. The press was used to extrude depleted, natural, and slightly enriched uranium rods, tubes, and shapes. The extrusion press operated until 1989. Until 2002, the building housed the site's environmental remediation activities, such as the handling and processing of radioactive and mixed waste.

The Main Plant was a steel-frame structure that contained both high- and low-bay areas. The High Bay was 53 ft × 288 ft × about 50 ft high. The attached Low Bay was 50 ft × 170 ft × about 20 ft high. In 2002, the Main Plant building was essentially disassembled by unbolting its structural steel frame and removing I-beams and columns by a mobile 100-ton crane. Steel columns and beams were then cut and sized to about 20-ft lengths so they would fit into intermodal containers for shipment to Utah. This cutting and sizing was performed by gas torch.

Synopsis of Event

Monitoring of this activity is shown in Table 1. Levels shown are without regard to respiratory protection.

Table 1. Personal Sampling for Lead During Cutting/Sizing of Main Plant Structural Steel

Date	Airborne concentration (mg/m^3)	8-hr time-weighted average (mg/m^3)
6/26/02	0.0044	0.00611
6/27/02	0.0094	0.01119
6/28/02	0.0294	0.03333
7/2/02	0.0322	0.03927
7/3/02	0.0344	0.03185
7/9/02	0.0250	***0.05952***
7/11/02	0.0170	0.01532
7/12/02	0.0065	0.01006
7/15/02	0.0029	0.00690
7/16/02	0.0068	0.01079
7/17/02	Less than detected	Less than detected

The paint on the steel frame structure was not analyzed for lead. Instead, all surfaces were considered potentially contaminated with lead, cadmium, chromium, and barium. Barium contamination was possible because this element was the main constituent of the salt bath in which the uranium metal was heated before extrusion, and barium contamination was found throughout the Main Plant.

The single lead exposure above the OSHA PEL is italicized and bolded. One sample showed a cadmium concentration of 3% of the TLV. The rest were <1% or undetectable. All chromium samples were <1% of the TLV. The high barium sample was >2% of the TLV, and all barium concentrations averaged 1.1% of the TLV.

Conclusion and Recommendation

Because of presumed potential exposure to lead, chromium, cadmium, and barium, engineering controls were implemented and respiratory protection was worn. The engineering control consisted of a locally constructed portable exhaust enclosure with HEPA filtration that was placed over the section of the beam being sized. Employees performing the cutting were also wearing full-facepiece air-purifying respirators with HEPA filtration. The protection factor of 50 provided by this respiratory protection protected employees from being overexposed to lead during this activity.

Case Study: Dismantlement and Controlled Demolition of Uranium Processing Buildings at the Fernald Closure Project

Introduction

Following their decontamination, Plants 4, 7, and 1 were scheduled for dismantlement and controlled demolition. Plant 4 was a steel-frame structure (80 × 110 × 102 ft high). It was constructed to house the processing of uranium hexafluoride to uranium tetrafluoride, although for most of its life, it was used for equipment storage. Plant 7 was a steel-frame structure (146 × 194 × 92 ft high) that contained the process for converting uranium trioxide to uranium tetrafluoride. Plant 1 was a steel-frame structure (80 × 202 × 65 ft high) that contained seven wet processes, including enriched materials reclamation, and three dry processes, including drum crushing/milling. The structural steel frames of all three plants were coated in lead paint, and lead flashing was also present.

Synopsis of Event

Air monitoring performed during the dismantlement and controlled demolition of these buildings is described in Tables 1 through 5. All exposures are 10-hr TWAs. "Above the PEL" means the concentration in air without regards to the protection factor (PF) of the respirators worn. The OSHA 10-hr TWA PEL referred to was 40 $\mu g/cm^3$.

Table 1. Plant 7 Breathing Zone Sampling for Inorganic Lead (except where noted)

Activity	Number of samples	Percent above 10-hr TWA PEL	Range ($\mu g/m^3$)	Average exposure ($\mu g/m^3$)
Saw cutting	4	0	8 to 13	9
Burning	5	0	<4 to 22	8.4
Cleanup	1	0	13	13
Cutting	3	0	3 to 5	4
Not described	6	83%	17 to 83	49.3
Flame cutting	5	100%	51 to 470	188
Inspection	1	0	6	6
Size reduction	3	0	8 to 16	12.3
Mechanical cutting with trackhoe	4	0	10 to 36	17.25
Controlled demolition area samples	20	0	<0.01 to 1.98	0.56

Samples were taken between April 14, 1994, and October 13, 1994.

Table 2. Plant 4 Summary Data – Breathing Zone Sampling for Inorganic Lead

Activity	Number of samples	Percent above 10-hr TWA PEL	Approximate range ($\mu g/m^3$)	Average ($\mu g/m^3$)
Torch cutting	36	42	2 to 1535	150
Torch helper	28	43	2 to 714	100
Shear, bolt cutter	37	0	2 to 14	4

Table 3. Plant 4 Detailed Data – Breathing Zone Sampling for Inorganic Lead (except where noted)

Work activity	Number of samples	Number above 10-hr TWA PEL	Range ($\mu g/m^3$)	Average exposure ($\mu g/m^3$)
Size reduction with bandsaw/sawzall	13	0	2 to 14	
Equipment removal phase				
Torch cutter of painted equipment	17	8	3.9 to 1535	243.7
Torch cutter's helper	15	8	24 to 661.1	125.7
Torch cutter (size reduction) of ammonia tank	2	1	2.78 to 105.6	Not provided
Washing down debris	15	0	0.2 to 27	Not provided
Structural steel demolition phase				
Torch cutter	19	7	2.2 to 306.1	55.7
Torch cutter's helper	13	4	2.2 to 714	89.9
Grinder	3	0	All <2.6	
Trackhoe shear operator	6	0	All <2.8	
Mechanically removing bolt heads	18	0	2.0 to 5.3	2.6
Implosion area monitoring	7	0	0.20 to 0.65	Not provided

Samples were taken from May 1995 to July 1996. The "torch cutter's helper" was responsible for positioning the exhaust ventilation during torch cutting.

Table 4. Plant 1 Summary Data – Breathing Zone Sampling for Inorganic Lead

Activity	Number of samples	Percent above 10-hr TWA PEL	Approximate range (μg/m^3)	Average (μg/m^3)
Torch cutting	291	66	2 to 1220.9	150
Torch helper	259	53	2 to 1331.2	90
Chop saw	3	66	3 to 100	50
Needle scaler	10	40	2 to 300	50
Mechanical, shear, and bolt cutter	17	0	2 to 28	6.76

Table 5. Plant 1 Detailed Sampling Data – Breathing Zone Sampling for Inorganic Lead (except where noted)

Work activity	Number of samples	Number above 10-hr TWA PEL	Range (μg/m^3)	Average exposures (μg/m^3)
Size reduction and removal of debris	4	0	2.4 to 27.3	14.6
<u>Equipment Removal Phase</u>				
Torch cutter	225	63	1.9 to 1200.9	138.8
Torch cutter's helper	238	128	1.8 to 133.2	90.9
Torch cutter and helper/size reduction	4	3	32.3 to 549.0	249.8
Torch cutter (after paint removal)	22	Unknown	16.0 to 749.0	190.7
Torch cutter's helper (after paint removal)	19	Unknown	1.8 to 181.8	53.3
Chopsaw/sawzall	3	2	2.6 to 122.5	55.4
Paint removal with grinder	1	0		11
Needle scaler	7	2	6.9 to 77.3	40.3

Sponge blasting (area samples)	2	2		884.4 and 971.7
Debris cleanup	20	0	1.2 – 7.9	Not provided
<u>Structural demolition phase</u>				
Torch cutter	12	10	14.6 to 332.8	123.8
Needle scaling	7	2	<2.2 to 299.5	60.9
Drilling	3	0	3 to 6	4.7
Structural steel sizing/stacking				
Trackhoe shear operation	5	0	2 to 14.6	5.2

Samples were taken from March to September 1996. The "torch cutter's helper" was responsible for positioning the local exhaust ventilation during the cutting activity.

Conclusions/Recommendations

The experience with Plant 7 in 1994 indicated that airborne lead levels were minimized through mechanical cutting and were highest during torch cutting and burning. Although local exhaust ventilation was provided during torch cutting, airborne levels were such that full-facepiece HEPA-filtered respiratory protection (with a PF of 50) and full anti-contamination clothing were still required.

When work began on Plant 4 in 1995, mechanical cutting was preferred, and torch cutting was permitted only after paint had been removed adjacent to where the torch cut would be made. However, during Plant 4 dismantlement, much torch cutting still had to be performed, and both local exhaust and paint removal were found to be ineffective in reducing airborne levels. Full-facepiece respiratory protection and anti-Cs continued to be worn by all employees, and torch cutting on equipment had to be limited to 2 hours per day. Nonetheless, actual exposure to employees was effectively limited as evidenced by the highest blood lead test results showing a concentration of 8.0 μg/dL, only slightly above the baseline level of 5.0 μg/dL, and well below the OSHA action level of 40 μg/dL.

During the dismantlement of Plant 1 in 1996, the problems with controlling airborne lead levels seen at Plants 7 and 4 continued. Local exhaust ventilation was not successful in reducing exposure, and paint removal was not effective. In fact, the highest percentage of exposures above the PEL was found among the torch cutter's helpers, who were responsible for positioning the local exhaust ventilation. The use of full-facepiece respiratory protection and full anti-contamination clothing continued.

In the end, the PF of the respiratory protection made it unlikely that employees were overexposed to lead generated during these activities. Success at preventing employee overexposure was also demonstrated by the results of blood lead testing, which showed the highest blood lead level recorded remained at 8.0 µg/dL.

Case Study: Dismantlement and Demolition of a Decommissioned Uranium Refinery Building

Introduction

From the 1950s until 1989, the Fernald Closure Project's Plant 2/3 converted natural uranium ore concentrates to UO_3 and enriched recycled materials to uranium oxide. Nitric acid was used to digest uranium metal, and denitration or other actions were necessary to recover the acid from the uranium oxide. As a result of these processes, nitric acid and uranyl nitrate hexahydrate (UNH) were spread throughout the plant. The vast majority of the nitric acid and nitrate-containing or -contaminated compounds were removed during safe shutdown. While these activities were ongoing, supplied-air respirators and air-purifying respirators with real-time monitors were worn. After safe shutdown was complete, only small quantities or residues of these compounds remained within the old plant processing systems or equipment.

Synopsis of Event

Table 1 shows personal sampling performed during dismantlement and demolition of the decommissioned building from February to July 2002.

Table 1. Breathing Zone Sampling for Nitrogen Dioxide

Sampling dates	Activity	Number of samples	High STEL (ppm)	High ceiling (ppm)	High TWA (ppm)
February and March 2002	Mechanical cutting	30	0	0.2	0
February and March 2002	Torch cutting	21 (16 samples were all 0.0)	**1.0** **0.2**	**19.4** **1.4** **0.7**	0.03
May 2002	Mechanical cutting	18 (7 samples were all 0.0)	0.0	0.2	0.0
May 2002	Torch cutting	6	0.1	0.6	0.01
June 2002	Mechanical cutting	22	0.1	0.5	0.0
June 2002	Shear cutting	1	0.0	0.1	0.0
July 2002	Mechanical cutting	4	0.0	0.1	0.0

Notes: The ACGIH Short-Term Exposure Limit (STEL), measured over 15 minutes, is 5 ppm. The OSHA ceiling limit is also 5 ppm. The ACGIH 8-hr TWA is 3 ppm. The bold italicized blocks under "High STEL" and "High ceiling" are the highest two and three values recorded, respectively.

When dismantlement and demolition of Plant 2/3 began, it was assumed that, with almost all nitric acid and nitrate residue and contamination gone, potential exposure to NO_2 could be controlled by local exhaust ventilation and other work practices. The sampling results shown in Table 1 do indicate that, in general, NO_2 exposure was well controlled. However, during this period, three incidents did occur indicating exposure to elevated levels of NO_2, but only one of these events was monitored. The monitored results, from March 12, 2002, are shown in boldface type in Table 1.

The monitored episode involved the torch cutting of a denitration pot. Local exhaust was in place, and, when an area monitor fell over, an employee bent in front of the downstream exit from the local ventilation system, which caused his monitor to alarm. Because the intake for this employee's respirator was located at his belt, it was both blocked by the employee's body and more distant from the source of the NO_2. His exposure was therefore likely lower than that indicated on the monitor, and this employee experienced no symptoms of exposure.

The two un-monitored incidents occurred on February 7 and March 13. In the February episode, the outer shell of a denitration pot was being torch cut. Prior to cutting, it had been washed down, and no sign of contamination was present. While cutting, slag fell onto the acid brick floor, and soon thereafter, a worker experienced an odor and symptoms indicating possible NO_2 exposure. The NO_2 was generated either through the heating of the nitric acid or uranyl nitrate contamination in the brick floor or by the torch heating some undetected contamination inside the wall of the pot.

The March 13 episode occurred during torch cutting of a shaft pump motor. Prior to cutting, the area had been washed down, and no contamination was visible; after cutting began, however, a blue flame was observed from under the pump base. Soon after, an employee experienced eye, nose, and throat irritation consistent with NO_2 exposure.

Finally, on August 12, another NO_2 exposure occurred while a team was nicking a kerosene line to facilitate the draining of any hold-up material. On this occasion, two employees experienced peak exposures reaching 6.5 ppm and 10.8 ppm. Neither worker experienced any symptoms of exposure during this event

Because of continued exposure to airborne radiological contamination, employees working within the building during these episodes had continued to wear full-facepiece powered air-purifying respirators with HEPA filters. These were not certified by NIOSH to provide protection from NO_2, and therefore no protection can be claimed as a result of their use.

Conclusion and Recommendations

Following the August exposure episode, work in Plant 2/3 was stopped pending a review of work practices and controls. As a result of the review, it was determined that the NO_2 could be generated by at least three mechanisms: thermal dissociation of nitric acid, the oxidation reaction of nitric acid on contact with metal, and the thermal decomposition of nitrates or UNH. It was also determined that, because the success of other controls could not be guaranteed, respiratory protection had to be provided against the potential for exposure to high levels of NO_2.

After resumption of work inside the building, insofar as practicable, cutting would be performed by vehicle-mounted shears that would put as much distance as possible between employees and potential NO_2 exposure. Whenever NO_2 exposure was considered possible, employees would wear NO_2 monitors set to alarm at 10 ppm, and they would be directed to exit the work area immediately if their alarms sounded.

The type of respirator worn would be determined by the potential for exposure to NO_2 at IDLH concentrations. When this was considered possible, such as in situations where an employee could not immediately leave the work area if a monitor alarm sounded, supplied-air respiratory protection operated in pressure demand with auxiliary SCBA would be worn. If the employee could exit an area immediately, supplied-air with auxiliary air-purifying escape or full-facepiece air-purifying respirators with filters certified by NIOSH for exposure to IDLH concentrations of NO_2 would be worn.

Case Study: Removal of a Concrete Wall and Cap in a Tritium Research Facility

Introduction

T Building at the Mound Laboratory was constructed in 1947 as a two-level underground research complex encased within 12 ft of reinforced concrete. Early in its life, research on polonium-210 contaminated part of the lower floor and its sumps. This contamination was sealed, and, although the polonium eventually decayed, the same lines became contaminated with process cobalt-60, which had to be shielded by the addition of a new concrete cap, essentially a new poured floor, which also facilitated drainage in the laboratory refurbished to contain tritium gloveboxes. With the closure of the site approaching and T Building far too massive to be demolished, its interior underwent complete decontamination, necessitating removal of the concrete cap and associated mortar block wall, in order to get at the original floor and contaminated floor drains beneath.

Synopsis of Event

The concrete cap and block wall were removed by either jack hammer, operated manually, or by a tracked pneumatic hammer known as a "dingo." During both activities, local exhaust ventilation was provided near the point of hammer impact. Misting of dust was performed whenever concrete was being broken, or its dust was gathered and dumped. Employees within the controlled area also wore either half-mask or full-facepiece respiratory protection (with assigned protection factors of 10 and 50, respectively), depending on whether there was thought to be the potential for airborne radiological exposure, as well as full anti-contamination clothing. The rooms in which the work was performed were treated as controlled areas. Because the dingo is gasoline-powered, carbon monoxide was monitored in real time.

Table 1 shows the results of personal and area sampling performed during the early days of cap removal.

Conclusion and Recommendation

The sampling results demonstrate the much greater potential for exposure during destruction of the mortar wall than during removal of the concrete floor cap. The wall was initially removed with small rotohammers, with employees working from scaffolding. During this work, significant dust was generated as loosened blocks fell, but this was reduced as misting techniques improved. Later, the dingo helped to eliminate the amount of physical labor; it also moved employees further from the point of dust generation. The limited number of samples does not demonstrate increased effectiveness of the dingo in reducing employee exposure to silica or respirable dust; however, the use of the dingo certainly reduced employee exposure to segmental (hand-arm) vibration caused by the jackhammer and rotohammers.

It will be noted that the detectable concentration for most quartz samples was higher than the ACGIH TLV; however, the limited duration of exposure reduced the likelihood that any employee was exposed in excess of the occupational exposure limit (without regard for respiratory protection), and the use of respiratory protection provided an additional protection factor.

Table 1. Breathing Zone and Area Sampling for Crystalline Silica and Total Dust

Sampling dates/type	Surface/ method	Agent sampled	Type/number of samples	TWA sampling results (mg/m^3)
Jan-Feb 2003	Block wall	Total dust	Personal (4)	***7.83***, 2.01, ***24.25***, 0.92
Jan-Feb 2003	Block wall	Total dust	Area (4)	2.28, ***6.32***, 0.5, 0.84
Jan-Feb 2003	Block wall	Quartz	Personal (1)	***0.46***
Jan-Feb 2003	Block wall	Quartz	Personal (1)	ND (0.04)
May 2003	Concrete cap/ jackhammer	Respirable dust	Personal (2)	1.2, 0.30
May 2003	Concrete cap/ jackhammer	Respirable dust	Area (2)	0.78, 0.69
May 2003	Concrete cap/ jackhammer	Quartz	Personal (3)	ND (0.09-0.1)
May 2003	Concrete cap/ jackhammer	Quartz	Area (3)	ND (0.09-0.1)
June 2003	Concrete cap/ dingo	Respirable dust	Personal (1)	0.61
June 2003	Concrete cap/ dingo	Respirable dust	Area (1)	0.24
June 2003	Concrete cap/ dingo	Quartz	Personal (1)	ND (0.07)
June 2003	Concrete cap/ dingo	Quartz	Area (1)	ND (0.07)

Notes:
(1) ND indicates not detected. The figure in parentheses is the detectable concentration.

(2) The ACGIH 8-hr time-weighted average (TWA) for quartz is 0.05 mg/m^3. ACGIH also recommends a TWA for inhalable and respirable particles, either insoluble or poorly soluble, not otherwise specified (PNOS), of 10 mg/m^3 and 3 mg/m^3, respectively. The OSHA PEL's being less protective, they were not referenced.

(3) TWA concentrations shown were for the length of the operation being performed, from 120 to 420 minutes. These levels are shown instead of 8- or 10-hr time-weighted averages because they illustrate worst-case exposure during these highly variable activities, when generally the longer exposure had the highest concentration. Samples with concentrations above the Action Level (assumed as half the TLV), without regard for respiratory protection, are bolded in the table.

CASE STUDIES: SOIL REMEDIATION

Case Study: Waste Pit Excavation and Soil/Debris Processing

Introduction

Cleanup of the Fernald Closure Project includes the remediation of six waste pits that were filled over the 37 active years of site operation as the (Uranium) Feed Materials Production Center. These pits contain magnesium filter cake and slag, metal oxides and refractory materials, raffinates from uranium wet process refining, sump sludges, coal fines, fly ash, graphite, and ceramics, all potentially contaminated with uranium, thorium, or radium. The pits cover 38 acres and must be excavated to a depth of 10 to 40 ft. Projections are that up to 1 million tons will be excavated. As of March 2003, 79 unit trains totaling about 4700 railcars and containing over 500,000 tons have been shipped to Envirocare of Utah for deposit. To meet their Waste Acceptance Criteria (WAC), the soil must have limited moisture content. To meet this and uranium content requirements, wet and dry soils may be blended on site, and some soils are dried in rotary dryers.

Synopsis of Event

Bulk sampling of the pits showed concentrations of more than 70 metals, organic compounds, herbicides, or pesticides with established occupational exposure limits. On the basis of the concentrations detected, a strategy for personal monitoring was developed for those compounds with the combination of the highest concentrations in the waste pits and lowest occupational exposure limits. Waste pit contents most likely to cause overexposure were determined to be arsenic, beryllium, vanadium, asbestos, and crystalline silica (quartz, cristobalite, and tridymite). To characterize employee exposure to these agents, monthly or bi-monthly monitoring of waste pit operations (laborers, heavy equipment operators, teamsters) and processing operations (hazardous waste operations, heavy equipment operators, geological technicians) was initiated. Additional job classifications were to be added if sampling results for the initial job categories were above the established Action Level. Typical personal sampling results are shown in Tables 1 and 2.

Table 1. Typical Personal Sampling Results for Metals

Sampling dates	Number of samples	Compounds sampled	Sampling results
November 1, 2002, to January 24, 2003	20	Arsenic, beryllium, and vanadium	All less than detectable

Table 2. Typical Personal Sampling Results for Asbestos

Sampling dates	Number of samples	Sampling results
November 1, 2002, to January 24, 2003	14	By PCM, less than detectable (6) to 0.0069 fibers/m^3 for 13 samples

Note: One sample showed a concentration by PCM of 0.1487 fibers/m^3, but was undetectable by TEM.

Personal sampling for arsenic, beryllium, vanadium, and asbestos began in late 1999 and is ongoing. Personal sampling for crystalline silica began in late 1999 and was performed until July 2002, when it was ended because of the consistently low exposure results.

Since the inception of sampling, only two of the samples for asbestos have been above an established TLV/PEL. Of 1,472 personal air samples taken for beryllium as of March 2003, none showed concentrations above the DOE action level. Despite the lack of detectable concentrations in these samples, employees performing these work activities continue to wear personal protective clothing and respiratory protection because of airborne radioactive contamination. Employees who work outside in the pit area as well as those who work inside the buildings that contain the dryers and loading areas are required to wear, at a minimum, full-facepiece, air-purifying respirators with HEPA filters.

Conclusion and Recommendations

The content of the waste pits is highly variable. For this reason, an aggressive air monitoring strategy was designed. The sampling strategy helped to demonstrate the lack of employee exposure so far. The high moisture presence in the contents of the pits undoubtedly helps to keep much of the contamination from becoming airborne. The use of respiratory protection to control exposure to radiological contamination also provides protection from any unanticipated or unmonitored particulates that may potentially be present in the waste pit contents.

Case Study: Washing of Uranium-Contaminated Soil

Introduction

From 1962 to 1989, the RMI facility in Ashtabula extruded depleted, natural, and slightly enriched uranium rods, tubes, and shapes for the Atomic Energy Commission. During that time, uranium dust generated by the process was exhausted to the outside, where it contaminated the site's soil to the north, west, and northwest of the extrusion plant. The method chosen to remediate this contamination was soil washing.

The soil washing process involved leaching uranium contamination from the soil into a solution and removing uranium from the solution through ion exchange. Leached solution and products of ion exchange were treated with a flocculent to promote agglomeration into larger particles. This stream was passed through a lamella, or clarifier, and belt filter press, before evaporation to a final uranium-rich residue. Processed clean soil would be dried and returned to the site. Workers processed 14,000 tons of contaminated soil during 1999 and 2000.

Synopsis of Event

During the soil washing process, the flocculent broke down generating amines, which were disconcertingly malodorous to some employees. Table 1 shows the results of area and personal sampling during the soil washing campaign of 1999 to 2000.

Conclusion and Recommendations

Because the amines were gases, they tended to escape to the atmosphere or rise to the highest levels within the southeast corner of the Soil Washing Building, immediately above the lamella clarifier, belt filter press, and the filter press sump. Screening with ammonia detector tubes identified the areas of highest concentration for later personal monitoring. In other portions of the building, amine concentrations were not detectable.

Three personal samples for trimethylamine, identified by the bold font, did come close to exceeding the TLV, but not the REL. Because the amines and ammonia cause similar irritation, their combined effect might have been even greater than suggested by their separate exposure levels.

Table 1. Air Sampling Results

Location	Chemical sampled	Airborne concentration (ppm)
Belt filter press	Dimethylamine	*Personal samples* - High, 0.07 10 of 12 samples undetected
Belt filter press and top of lamella	Dimethylamine	*Area samples* – High, 0.05 18 of 22 samples undetected
Belt filter press	Trimethylamine	*Personal samples* – Highs, **4.84, 4.64, 4.24** Average of 12 samples, 2.22
Belt filter press and top of lamella	Trimethylamine	*Area samples* – Highs, **16, 13, 5.9(2), 5.52** 6 of 19 samples undetected Average of 13 other samples, 3.93
Belt filter press	Ammonia	*Personal samples* – High, 7.28 Average of 3 samples, 4.68
Belt filter press and top of lamella	Ammonia	*Area samples* – Highs, 27.26, 24.3, 23.44, 21.44, 19.52, 17.04 Average of 47 samples, 7.95

Notes: The ACGIH TLV TWA is 5 ppm for dimethylamine and trimethylamine and 25 ppm for ammonia. The OSHA PEL is 5 ppm for dimethylamine and 25 ppm for ammonia. There is no PEL for trimethylamine; however, the NIOSH REL is 10 ppm.

Some bolded area samples on top of the lamella and the belt filter press showed concentrations in excess of the TLV for trimethylamine, and the effect of this exposure would have been amplified by the associated exposure to ammonia. However, operation of the Soil Washing Plant did not require workers to remain on a regular basis in the areas of the plant where the concentrations were highest. When these areas of highest concentration were identified, administrative and engineering controls were implemented. These controls consisted of a camera installed to monitor the belt filter press from the Soil Plant Control room, eliminating the need for an employee to stay in the high-exposure areas. Personnel were also rotated when access to the belt filter press or lamella was required, and dilution ventilation was provided near the source of the amines and ammonia. Changing the flocculent polymers used in the lamella clarifier and belt filter press also helped to reduce amine and ammonia generation.

Case Study: Soil/Debris Excavation and Deposition at an On-Site Disposal Facility (OSDF)

Introduction

The OSDF at the Fernald Closure Project, when filled, will hold 2.5 million cubic yards of soil and debris. When completed it will be about 3700 ft long, 800 ft wide, and 65 ft tall, covering 56 acres. The OSDF will be lined on its bottom and capped. The 5-ft-thick liner system will include compacted clay 3 ft thick beneath a leak detection drainage and leachate collection system. The 9-ft-thick cap will consist of compacted clay topped by a cover drainage layer and bioinstrusion barrier to prevent roots from penetrating the cap.

Five categories of material may be deposited in the cell. The vast majority, categories one and two respectively, are soil and soil-like material having contamination within the cell's waste acceptance criteria (WAC), and materials that can be spread and compacted in mass (such as building rubble, drywall, broken up foundations) having fixed radioactive contamination. Construction and filling of the OSDF will proceed in phases, with one cell being capped, while another is being filled, and a third is excavated. Up to nine cells may be constructed and filled. Excavation for a cell is performed below grade and the liner is put in place. Building debris and other materials are brought to the cell from a nearby transfer area where they accumulate. Soil and debris are brought in and either dumped or placed and then covered with soil and compacted.

Synopsis of Event

Among the soil to be deposited in the cell was that from the FCP's Southern Waste Unit (SWU). Within the SWU was a flyash pile that contained a high concentration of crystalline silica. From October 1999 to August 2000, air monitoring was performed while this soil was excavated or while it was deposited into the OSDF. The results of this monitoring are shown in Table 1.

Table 1. Breathing Zone Sampling for Respirable Crystalline Silica (Quartz, Critobalite, and Tridymite)

Sampling dates	Number of personal samples	Non-detectable samples	Activity sampled and location
October/November 1999	8	7	Excavation of SWU soil / filling OSDF cell #3
March/April 2000	12	12	Same
June 2000	2	2	Same
August 2000	2	2	Same

Workers monitored during excavation included operators of equipment and those who were monitoring excavation for prohibited items and spraying soil to control dust. Workers monitored during filling of the OSDF were those who were spotting for vehicles and monitoring for deposition of prohibited items. *The single personal sample that exceeded the detectable limit also exceeded the ACGIH TLV (of 0.1 mg/m^3) with an 8-hr* *time-weighted average concentration of 0.14 mg/m^3*. There was 23 % crystalline silica in the sample. Given this percentage, the OSHA PEL for this sample was 0.4 mg/m^3. The overexposed employee was applying water for dust control, and was standing outside a 25-ft exclusion zone that required the use of respiratory protection.

Conclusion and Recommendations

The single overexposure apparently occurred because the employee was standing directly downwind of the excavation on a windy day. After the initial overexposure, the exclusion zone around excavation and dumping was expanded to 75 ft and employees were directed to avoid standing directly downwind. To control dust, soil undergoing excavation, loading, transportation, and compaction was sprayed with water. The results of air sampling conducted after these changes were made indicated that the controls were adequate to prevent crystalline silica overexposure.

References:

Guidance

- 29 CFR 1910.1025, OSHA General Industry Standard for Inorganic Lead
- 29 CFR 1926.62, OSHA Construction Industry Standard for Inorganic Lead
- American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances for 2003
- DOE Order 440.1A, Worker Protection Management for DOE Federal and Contractor Employees

Site Specific Reports (All for the DOE Fernald Closure Project)

- Report Number: IH-3-0007-04, Evaluation of Personnel Exposures to Asbestos, Lead, Dust and Heat Stress during Decontamination and Dismantling of Plant 7, November 8, 1994
- Report Number: IH-03-0001-16, Results of Industrial Hygiene Monitoring Conducted During the Decontamination and Dismantling of Plant 4, December 11, 1996
- Report Number: IH-03-0004-07, Results of Industrial Hygiene Monitoring Conducted During the Decontamination and Dismantling of Plant 1 Complex – Phase 1, April 15, 1997
- Report Number: IH-07-0079-01, Results of Industrial Hygiene Monitoring Conducted During the Disposition of Lead Batteries and Lead Shapes by the Mixed Waste Group for the Waste Management Project, September 13, 2002